

Farming with grass—for people, for profit, for production, for protection

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Achieving sustainable mixed agricultural landscapes in grassland environments is a broad, perhaps audacious goal; yet, the need for change in current agricultural systems is undeniable. Today's agriculture and food systems are deeply rooted from the era of cheap energy and fertilizers, an assumption of static climate, and the ability of entities to "externalize" environmental and social costs. With society currently facing the end of cheap energy and a growing awareness of climate change linked to rising concentrations of greenhouse gases, additional pressures are likely to emerge—expanding human population and increasing competition for scarce water supplies. Change in, and uncertainty about, such key drivers of ecological and economic systems require a fundamental reassessment of agricultural and food systems. It is time to rethink how agriculture is performed; we need more secure and resilient food systems and enhanced economic opportunities in rural communities. With agriculture occupying about 40% of the global land surface, goals for clean water, clean air, and diverse biota cannot be met without good ecological stewardship of agricultural lands. Grasses and other perennials have a major role to play in more diverse and resilient agricultural systems needed to meet the multitude of ecological functions derived from agricultural lands.

The Farming with Grass conference, held in Oklahoma City, Oklahoma, from October 20 to 22, 2008, brought together diverse stakeholders in grassland environments to (a) help assess the current condition of agriculture, (b) consider alternative production scenarios for grassland agricultural ecosystems, (c) identify key issues hindering the development of more sustainable systems, and (d) clarify

the role of science and government policies in developing options for the future. Proceedings of the conference, *Farming with Grass: Achieving Sustainable Mixed Agricultural Landscapes*, are available as an e-book at <http://www.swcs.org/fwg>. Despite enormous uncertainty, human society must continue to rely on agriculture for its food, feed, fiber, and fuel, while maintaining and improving ecosystem function. Agriculturists increasingly face trade-offs needed to manage different food, feed, fiber, fuel, and ecosystem enterprises. However, we oftentimes lack tools to comprehensively assess short- and long-term costs and benefits of alternatives. Agriculturists and conservationists are called to form new working alliances to identify sustainable production, marketing, and policy approaches to simultaneously support social equity (people); economic viability (profit); food, feed, fiber, and fuel systems (production); and natural resource preservation and biodiversity enhancement (protection).

STATUS AND TRENDS IN TYPES OF AGRICULTURAL PRODUCTION

US agriculture has undergone significant transformation from the beginning of the 20th century to present, driven by a combination of historical, technological, and policy changes (Hanson and Franzluebbers 2008). Low commodity prices and rural poverty in the 1930s led to development of commodity-based price supports in US farm policy that still influence policy today.

While much of US farm policy focuses on row crops, more than half of agricultural land and farm gate receipts are derived from animal agriculture. Beef producers are primary users of grasslands, and they have a large stake in future policies relating to grasslands agriculture. The US beef industry consists of five distinct segments: (1) cow/calf production with numerous producers often on small land holdings; (2) stockers with fewer producers who purchase weaned calves from multiple farms and frequently transport animals toward

the center of the country; (3) feedlots, in which large numbers of animals are managed within a few operations, predominantly in the High Plains regions of Texas, Kansas, and Colorado; (4) slaughter/packing plants, in which four corporations currently process over 80% of the beef cattle; and (5) wholesalers/retailers, who transport beef products to population centers throughout the nation (Phillips et al. 2009). Such systems developed when energy and feed were inexpensive, but they now face great stresses with market volatility.

Future agricultural production systems must possess an inherent capacity to adapt to change to be sustainable. Trends in population growth, energy use, climate change, and globalization will challenge farmers and ranchers to develop innovative production systems that are highly productive, but environmentally sound (Hanson and Hendrickson 2009). Sustainable agricultural systems emphasize the need to mix complementary crops and animals in appropriate times and places, keep the soil covered with growing crops and mulches, and use detailed knowledge of ecological relationships to reduce the use of purchased inputs, such as pesticides and fertilizers, and to solve problems.

Gale Buchanan, USDA Under Secretary for Research, Education, and Economics, in his opening speech to the Farming with Grass conference, identified four grand challenges that agriculture must address during coming decades:

- Achieving sustainable bioenergy production
- Adapting to and mitigating global climate change
- Improving water quality and availability
- Ensuring food security

While industrial agriculture has been held up as a model of efficiency, its efficiency has been assessed from a largely economic perspective that has previously discounted environmental costs associated with ecologically neglecting agricultural practices or systems. Kirschenmann

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(2009) reminded us that while current systems are highly productive, there are also other highly productive models available that are more ecologically sensitive, such as poly-culture. Ikerd (2009) described the approaching end of the industrial food system, driven by changes in consumer demand for locally grown foods that have less impact on Earth's climate and are less reliant on fossil energy and other limited resources.

Key issues related to status and trends included the following:

- Agricultural systems will be forced to change as a result of a multitude of ecological and social stresses.
- Grass-based agricultural systems can support greater natural resource conservation, improved rural livelihoods, greater diversity of farm income and farm-sector stability, and national security interests.
- Transition approaches from the current industrial model to a more diverse combination of systems (all of which should be ecologically sensitive, economically fair, and ethically based) are in great need.

ENVIRONMENTAL, SOCIAL, AND ECONOMIC BENEFITS OF MIXED GRASSLAND LANDSCAPES

Grasslands, and in particular the vast area of the Great Plains of North America, have provided numerous ecosystem services, including hydrological function to provide fresh water in ground and surface reservoirs, high soil quality to maximize nutrient cycling and habitat for soil organisms, sequestration of soil carbon to help maintain the delicate balance of greenhouse gases in the atmosphere, and surface cover to naturally mitigate against erosion. Grasslands also provide an abundance of forage available for livestock production and livelihoods of people that value the vast open spaces they occupy. Too often, however, grasslands have been exploited through either (1) excessive cultivation of the deep, rich soils that developed over the millennia (such as in the Great Plains of North America and Pampas of South America), resulting in enormous loss of soil organic matter, native fertility, and soil sediment, or (2) excessive livestock



Brangus cattle grazing native prairie in Oklahoma. Photo credit: Mike Brown, USDA ARS, El Reno, Oklahoma.

stocking on semi-arid and arid rangelands situated in brittle environments (such as the southwestern United States and Sub-Saharan Africa), resulting in loss of vegetative cover, low resilience, excessive soil erosion, and poor rural livelihoods.

Agricultural lands can be viewed as multifunctional, providing feed, food, and fiber, as well as stable soil and water conservation to protect the environment. Grasslands, in particular, can provide diverse multifunctional economic and environmental benefits. Sanderson et al. (2009) questioned whether all of these services can be met at the same time, given the increasingly divisive stress between profitability and environmental protection.

In revisiting the Buffalo Commons—a metaphor intended to generate discussion of alternative futures for the Great Plains that would ultimately return land back to native grasses and focus land use on ecotourism and other extensive rangeland/prairie enterprises—Popper and Popper (2009) noted the evolution of the idea over the past 20 years. Rather than a federally led effort as they originally envisioned, locally led efforts—individuals and community groups—have been building and maintaining a sense of place unique to the Great Plains prairies to create economic opportunities.

Agriculture near large population centers is at great risk of development, but

offers the potential to supply local food markets, while protecting the hydrologic and ecologic function of the peri-urban landscape. Grass-fed dairies in Wisconsin provide a model for market development of local food products (Paine 2009). Consumers of farm-crafted cheeses and other local foods respond to “narrative” marketing because they are interested in the people and the story behind a food product, as well as the quality of the product.

Key issues related to benefits of grassland ecosystems included the following:

- A need to make social and policy changes before disaster occurs, such as that during the Dust Bowl of the 1930s and following excessive pollution of ground and surface waters during the post-World War II agricultural revolution



People gathering at a farmers market in Missouri. Photo credit: USDA NRCS, Missouri.

- Balancing land preservation with land utilization for economic and ecological stability
- Effective technology transfer mechanisms for ecologically based agricultural business models
- Defining the extent of land use changes in response to sugar and cellulosic biofuel production systems, as well as defining the economic, environmental, and social trade-offs of such changes

FACTORS DRIVING CHANGES IN GRASSLAND ENVIRONMENTS

Many factors are driving change in grasslands, as well as in other agricultural lands. Greenhouse gas emissions and the threat of global warming have emerged as an underlying force reflecting historically recent, yet widespread, fossil fuel combustion pervading the industrial model of agricultural production, as well as the unrestrained energy use and ecological inefficiency of industrial production systems. Water availability and quality are also factors driving the need to redesign agricultural systems, owing to the limited fresh water supply shared between agricultural and metropolitan needs and the recognition of nutrient and bacterial leakages from ecologically inefficient agricultural systems with high synthetic fertilizer and pesticide inputs and concentration of animal feed operations.

Allen et al. (2009) described the potential for diversifying agricultural systems in the Texas High Plains by incorporating forage grasses and beef cattle grazing into crop rotations. Cotton yield was significantly improved in rotation with forages. Integrated crop–livestock systems also had lower irrigation water requirements, were able to maintain net income, reduced water and wind erosion (with associated improvements in air and soil quality), and increased soil organic carbon and biological activity.

Resistance to change can be a strong force on an individual, as well as on an institutional level. Arbuckle (2009) described major conceptual barriers to implementation of environmentally and economically based silvopasture systems (forest thinning with undersown pastures) in Missouri that might have been overcome with

Mixed tall fescue–bermudagrass pasture in Georgia. Photo credit: Alan Franzluebbers, USDA ARS, Watkinsville, Georgia.



prior interactive educational and practical experiences. Policy makers at a national scale also have a need to understand factors influencing change in agriculture. In the prairie provinces of Alberta and Saskatchewan, Census of Agriculture data were evaluated to identify shifts in farm operations and why they might be occurring (Huffman and Saha 2009).

Key issues related to factors driving change included the following:

- Adaptation and adoption of sustainable, mixed grazing, cropping, and forestry systems for different grassland environments
- Assessment of production, ecological, and economic responses to alternative management systems in both short and long term
- Development of robust technology transfer protocols to (a) assemble key organizations necessary to implement change, (b) educate stakeholders and the public, and (c) promote innovation in solving far-reaching problems faced by individuals and communities within a region.

ASSESSMENT TOOLS FOR MONITORING AND PREDICTING CHANGES IN GRASSLAND AGRICULTURAL SYSTEMS

Many tools are available for targeting ecological, production, economic, policy, social, and community impact assessments, and these tools are critical because “if you

can’t measure it, you can’t manage it.” Some tools are applied at field or farm scale, but these tools are often tailored toward conventional systems and may need further development or refinement for more diversified, grass-based systems, including mixed perennial–annual rotations, management-intensive grazing, or multiple-species grazing within a landscape context. Landscape-level tools are essential for inventory and water quality assessments. There will be an increasing demand for assessment tools—both simple, practical tools for individual decision making and highly complex tools that incorporate suites of models and databases into a geospatial framework.

Global change is a key issue requiring a sophisticated assessment framework to evaluate scenarios for adaptation and mitigation. Ojima and Corell (2009) sounded the call of urgency regarding climate change, which includes a multitude of issues—global warming, impacts of nitrogen deposition on nonagricultural landscapes, effects of changing land use on ecosystem processes, and altered precipitation patterns within a region. A specific tool to bridge the goals of production agriculture and conservation ecology—the Healthy Farm Index—was developed to assess impacts of organic and sustainable agriculture on a variety of ecosystem services, including farm biodiversity (Quinn et al. 2009).

Key issues related to assessment tools included the following:

- Adopting and adapting simple and complex assessment tools for promotion of sustainable agricultural systems at field, farm, watershed, landscape, and national levels
- Including as many key stakeholders as possible in assessment and evaluations so that prompt and robust adaptation and mitigation strategies can be implemented

SCIENCE AND POLICY NEEDED TO SUSTAIN AGRICULTURE IN MIXED GRASSLAND ENVIRONMENTS

With the diversity of grassland ecosystems and the multitude of species in mixed crop-grass systems, there are many gaps in our understanding. While some countries have supported strong research and extension programs in grasslands agriculture for decades, research investment for grassland agriculture has drastically lagged behind research investment for commodity crops in other countries and globally.

Boody et al. (2009) evaluated multifunctionality of grasslands within a watershed in the Great Lakes region. Using scenario analysis, introduction of perennials into a watershed indicated the potential for many environmental benefits. Cellulosic energy buffers could create a large water quality benefit. Rotational grazing could also improve water quality, while providing strong market return at the watershed scale. With such positive impacts indicated by these modeled scenarios, there is a need for field- and watershed-scale research to continue to enhance our understanding of these systems and processes.

Boody et al. (2009) also called for a “joined-up” farm policy, in which all components of the farm policy would work toward common goals, rather than having some components of the US farm bill work against goals of other components. French (2009) discussed many unintended consequences of current US farm policy. There is a need to confront policies that create barriers to more just agriculture and food systems. US farm policy has resulted in 2% of farms receiving 30% of payments and crops that produce 30% of farm gate receipts receiving 92% of agricultural pay-

ments. Conservation and land stewardship should be at the center, not the periphery, of farm policy, which should ensure that environmental services and public goods are tied to farm-income support payments (French 2009).

The legal system often imposes relatively inflexible requirements for agricultural producers. With a required change in poultry manure management following legal settlement between the City of Tulsa and several poultry integrators operating in the Eucha-Spavinaw watershed of Oklahoma and Arkansas, Sharpley et al. (2009) evaluated the role of research and extension in supporting landowners who face changes in production to meet environmental outcomes.

Key issues related to science and policy included the following:

- Research on grass-based livestock production systems is needed to (a) lengthen the growing season with various forages; (b) link forage quality, meat nutritional composition, and human health; (c) identify suitable adaptation and mitigation strategies to combat climate change, such as through greater soil organic carbon sequestration; and (d) develop multiple and mixed livestock grazing systems to increase resilience of a system and reduce grazing system impacts on wildlife and biodiversity.
- Farm policies are needed that would reverse the trends in the 20th century for increasing farm size, loss of rural population, consolidation and concentration of production and marketing, decline in grasses and perennial crops, separation of crop and livestock production, and greater absentee landownership.
- In the short term, ecologically based, agricultural-system knowledge, technology, and approaches should be incorporated into existing agricultural policy structure.
- In the longer term, ecologically based, grass-root organizations need to form wider alliances to positively affect a larger proportion of agricultural stakeholders.
- Suitable alternatives to farm legislation are needed that avoid perverse incen-

tives and target sustainable agricultural systems more effectively.

- Seamless approaches are needed among business, government, and agricultural sectors to create farming systems that are ecologically pertinent to a region, that utilize nutrient and other natural resources wisely, and that are sustainable into the future.

MOVING FORWARD

Since the early 20th century, US agricultural policy has favored production of selected commodity crops to provide feedstock for industrial agricultural products. Policies have distorted markets and resulted in production and market concentration within the agricultural sector, increasing farm size, reducing rural population, and suppressing rural economic activity. Additionally, a policy system that allowed entities to externalize environmental and social costs has created an agricultural system highly dependent on fossil fuel and purchased inputs, such as fertilizers and pesticides. Agricultural practices have resulted in loss of diversity, soil degradation, atmospheric emissions of greenhouse gases, and water quality problems. Unfortunately, commodities that are subsidized by taxpayers are increasingly processed into foods that are high in sugars and heavy in saturated fats, contributing to a national epidemic of diet-related diseases, such as diabetes, heart disease, and some cancers. Future agricultural systems will need to capitalize on the considerable technical and economic capacity within existing agricultural organizations and businesses, but operate under policies that address the pressing challenges of food supply, energy constraints, climate change, water limitations, and growing global population. Many types of agricultural systems will be required to meet diverse human needs in diverse environments.

Participants at the Farming with Grass conference contributed to a vision for sustainable agriculture and identified key gaps in scientific knowledge, technological capacity, and policy instruments. Conversations culminated in several key messages, which will be useful in supporting “grassroots farmers” who want to incorporate grasses and perennials into



Farmer receiving advice on pasture condition in Missouri. Photo credit: USDA NRCS, Missouri.

their production systems, who are committed to environmental stewardship of their land, and who depend on the vitality of rural communities in which they live.

Messages to Policy Makers

- Difficult times require broad vision and practical solutions—Investing in land stewardship and rural communities will build social, natural, and financial capital.
- Policies should ensure maximum environmental “bang for the buck”—While conservation and good stewardship are desirable on any property, achieving specific environmental goals, such as water quality improvement in a particular water body, improved air quality in a particular city, or protection of a particular at-risk species, can best be achieved by targeting the types of conservation practices onto particular land that has the greatest impact on the desired environmental outcome. Targeting is a common-sense approach for public funds to support agricultural conservation.
- Recognize the need for food security—Agriculture and food systems are vulnerable when they rely on imported oil due to potential price shocks that can disrupt markets.

Message to Conservation Organizations

- Agriculture can deliver environmental services—Agriculture occupies a large portion of the nation’s land, and protection of natural resources can only be achieved in partnership with agriculturalists and land owners/managers. Sustainable agricultural systems that maintain a vegetative cover on the

soil, use limited external inputs, support healthy soil nutrient cycling, and provide habitat for diverse species can help sustain water, atmospheric, and biologic resources.

Message to Rural Community Leaders

- Sustainable agriculture can enhance economic opportunities—Ecosystem services provided by sustainable agricultural systems are amenities that can attract residents and visitors and offer opportunities to develop recreational and agricultural tourism, such as bird watching, boating, fishing, or hunting. Additionally, communities can work with farmers to help develop local foods systems, generating jobs along the supply chain and providing affordable and healthy foods to residents.

Messages to Farmers and Farmer Support Organizations

- Gaining market access and creating economic sustainability—Integrating grasses and perennials into agricultural systems can reduce input costs, enhance profitability, and reduce risk by producing more diversified products.
- Freedom from government programs—Current policies do not provide an even playing field for many farmers. Certain crops are favored and innovation is stifled.

Messages to Consumers and the General Public

- Safe food and good health for families and communities—Local food products can be healthy and secure. You know more about how food was produced and the impacts of the food production on the environment.

- Clean and healthy environment—Sustainable agricultural systems can contribute and consumers can support sustainable management practices through their purchase choices.

There are a myriad of challenges ahead in achieving sustainable mixed agricultural landscapes in grassland environments, but the need to meet these challenges is undeniable. Four grand challenges of agriculture—achieving sustainable bioenergy production, adapting to and mitigating global climate change, improving water quality and availability, and ensuring food security—are interrelated and must be addressed in a systematic way so that the solution of one problem does not create a problem in another. Addressing these challenges will require a fundamental rethinking of agriculture to maintain or increase production, while mitigating past environmental damage, protecting biological diversity of domesticated and wild species, reducing dependence on fossil fuel, providing healthier foods (particularly to children and the poor), and increasing economic and cultural opportunities in rural areas. Past US agricultural policies have favored a few commodity crops and have disfavored producers of grasses and other perennial crops. Perennial species, incorporated into diverse agricultural systems, have great potential to enhance agro-ecosystem resilience in the face of uncertain climate and market conditions. In addition, by developing more on-farm and rural enterprises to provide products for local food systems, sustainable mixed agricultural farming systems can help revitalize communities and provide healthy food options to schools, families, and institutions.

ACKNOWLEDGEMENTS

Key issues and messages to stakeholders were developed during discussion among the participants. The authors thank Constance Neely, Vice President, Heifer International, Little Rock, Arkansas, for excellent facilitation of the conference discussion sessions.

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